Novel Compression and Fueling Apparatus to Meet Hydrogen Vehicle Range Requirements

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Objectives

- Develop or identify components suitable for 700 barg hydrogen refueling
- Develop an isothermal compressor for low cost, gaseous compression
- Demonstrate a prototype compressor at a suitable site

Technical Barriers

This project addresses the following technical barrier from the Hydrogen Delivery section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

- B. High Costs of Hydrogen Compression

Approach

- Develop a compression cycle that utilizes low cost components
- Test fluids for use in the compression cycle
- Develop components for 700 barg fueling
- Test various components in service

Accomplishments

- Developed a compression cycle that is low cost
- Built a test skid for testing of fluid properties at various hydrogen pressures
- Developed new components with leading vendors for 700 barg fueling
- Initiated testing of high pressure components for durability and life

Future Directions

- Build a prototype compressor with a capacity of approximately 1 nm3/hr
- Test alternate working fluids

Introduction

The goal of this project is to develop a low cost, isothermal gaseous compressor. The first step of this project was to identify all possible processes which could be used to compress gaseous hydrogen. Construction and capital costs were then estimated, and the design was refined based on the target costs.

A parallel effort was begun to develop high pressure fueling components that have the desired cost, life, and performance.

Approach

Each process was modeled using ASPEN Plus (modeling software) to determine system efficiency and to determine component sizing. Local fabricators with relevant experience estimated the construction costs.

We approached Air Products preferred vendors and began co-development of a number of valves and instruments to support 700 barg fueling.

Results

We have tested a number of components and fitting types in hydrogen fueling service. Based on this experience, we have determined that medium pressure cone and thread fittings are the most robust fittings for these pressures.

We have also found that a number of hydrogen fueling components require additional refinement. Permeation of softgoods or diaphragms and explosive decompression are two common issues.

High pressure storage is the most difficult area as no cost-effective options exist today. Steel vessels at 14,000 psig maximum allowable working pressure, required for cascade filling, are very expensive. Stainless steel machined vessels are also very expensive. Composite storage vessels hold the most promise. Composite storage vessels have currently been granted Department of Transportation exemptions for specific tanks of specific design. No American Society of Mechanical Engineers (ASME) exemptions or certifications exist for a stationary application like fueling.

We have just begun testing various fluids to determine their impact on the thermodynamics of isothermal compression of hydrogen.

Conclusions

- An isothermal compressor is feasible.
- Thermodynamics of process fluids with hydrogen are unavailable at 700 barg, so we will develop our own data.
- High pressure components can be developed at reasonable prices for 700 barg fueling.
- Storage is the most difficult component as it must be rated at 135% of the fueling pressure.
- Composite cylinders could one day provide a viable storage solution with lowered costs and ASME approval.

References

1. Vendors - Compressor components, instruments, fittings, and valves.

FY 2003 Publications/Presentations

1. Poster Session at 2003 Annual Program Review and Peer Evaluation

Special Recognitions & Awards/Patents Issued

1. Patent application is pending on the compressor cycle.